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Sertifikaat

REPUBLIEK VAN SUID-AFRIKA

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PATENT OFFICE

REPUBLIC OF SOUTH AFRICA

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DEPARTMENT OF TRADE AND INDUSTRY

Hiermee word gesertifiseer dat
This is to certify that

the documents attached hereto are true copies of the application form, provisional specification and drawings of South African Patent Application No. 97/1819 in the name of SALBU RESEARCH AND DEVELOPMENT (PROPRIETARY) LIMITED

REC'D 18 MAY 1998
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Filed : 3 MARCH 1997

Entitled : ENHANCED CELLULAR COMMUNICATION SYSTEM

PRIORITY DOCUMENT

...teken te / ...ned at PRETORIA in die Republiek van Suid-Afrika, hierdie / in the Republic of South Africa, this 12 dag van / day of March 98

Registrateur van Patente
Registrar of Patents

G.P.-S. 019-0096

SPOOR AND FISHER

REPUBLIC OF SOUTH AFRICA

PATENTS ACT,1978

FORM P.1

APPLICATION FOR A PATENT

AND ACKNOWLEDGEMENT OF RECEIPT

(Section 30 (1) - Regulation 22)

R 060,00

The granting of a patent is hereby requested by the undermentioned applicant on the basis of the present application filed in duplicate

OFFICIAL APPLICATION NO.			S AND F REFERENCE
21	01	971819	JP/S1199 /aa

FULL NAME(S) OF APPLICANT(S)

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TITLE OF INVENTION

54	ENHANCED CELLULAR COMMUNICATION SYSTEM

THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANYING FORM P.2. THE EARLIEST PRIORITY CLAIMED IS:

COUNTRY: NONE NUMBER: NONE DATE: NONE

~~THIS APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO.~~

21	01	

~~THIS APPLICATION IS A FRESH APPLICATION IN TERMS OF SECTION 37 AND IS BASED ON APPLICATION NO.~~

21	01	

THIS APPLICATION IS ACCOMPANIED BY:

- [x] 1. A single copy of a provisional ~~or two copies of a complete~~ specification of 12 pages.
- [x] 2. Drawings of 2 sheets.
- [ ] 3. Publication particulars and abstract (Form P.8 in duplicate).
- [ ] 4. A copy of Figure .... of the drawings (if any) for the abstract.
- [ ] 5. An assignment of invention.
- [ ] 6. Certified priority document(s).
- [ ] 7. Translation of the priority document(s).
- [ ] 8. An assignment of priority rights.
- [ ] 9. A copy of the Form P.2. and the specification of S.A. Patent Application No.
- [ ] 10. A declaration and power of attorney on Form P.3.
- [ ] 11. Request for ante-dating on Form P.4.
- [ ] 12. Request for classification on Form P.9.
- [x] 13. Form P.2 in duplicate.

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Dated : 3 March 1997

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REGISTRAR OF PATENTS

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

PROVISIONAL SPECIFICATION

(Section 30(1) - Regulation 27)

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21	01	971819

LODGING DATE

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FULL NAME(S) OF APPLICANT(S)

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FULL NAME(S) OF INVENTOR(S)

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TITLE OF INVENTION

54	ENHANCED CELLULAR COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

THIS invention relates to a method of transmitting data between stations in a cellular wireless communication system, and to a system which employs the method.

Conventional cellular wireless communication systems comprise a plurality of fixed stations each of which defines a cell of coverage. Mobile stations can communicate with a fixed station provided that they are within the relevant cell. In order to provide complete coverage of a predetermined geographical area, the location of fixed stations is selected so that the cells overlap, to minimise or eliminate "dead" areas.

The above arrangement has the effect that each cell has a central, interference free zone, and an outer zone which overlaps with outer zones of one or more adjacent cells, in which interference can take place. In these latter areas, a mobile station transmitting into one cell will produce interference in adjacent cells. In addition, in the overlapping zones, transmissions from adjacent fixed stations will interfere with each other.

In order to deal with this problem, conventional cellular networks are arranged so that adjacent fixed stations transmit at different frequencies and/or different time slots to avoid interference. In a multi-cell network, this requires a high level of time synchronisation between the various fixed stations.

SUMMARY OF THE INVENTION

According to the invention there is provided a method of transmitting data between stations in a cellular wireless communication system comprising a plurality of mobile and a plurality of fixed stations, the method comprising locating a plurality of fixed stations so that each fixed station has an effective coverage area which does not overlap with the coverage areas of adjacent fixed stations, thereby defining zones of no coverage between adjacent fixed stations, and relaying data messages from sender stations outside the coverage area of a destination station to the destination station via mobile stations located in zones of no coverage.

Further to the invention there is provided a cellular wireless communication system comprising a plurality of mobile stations and a plurality of fixed stations, each station being able to transmit data to and receive data from other stations, the fixed stations being located so that each fixed station has an effective coverage area which does not overlap with the coverage areas

of adjacent fixed stations, thereby defining zones of no coverage between adjacent fixed stations, and the mobile stations being adapted to relay data messages received from a sender station to a destination station, so that a mobile station located in a zone of no coverage will function as a relay to other stations.

Preferably, a data message transmitted by a mobile station located in a zone of no coverage will be relayed by a further mobile station within the zone of coverage of a fixed station to that fixed station, and vice versa.

The mobile stations are preferably adapted to limit their transmission power, when relaying messages to a fixed station or a mobile station in the effective coverage area of a fixed station, to avoid interference with said fixed station.

The mobile stations are preferably adapted to monitor data transmissions to and from fixed stations and to relay messages opportunistically when said data transmissions are not occurring or at a sufficiently low power level to avoid interference therewith.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a simplified schematic diagram showing the coverage of cells in a conventional cellular network;

Figure 2 is a similar simplified diagram, showing the cellular coverage of fixed stations in a network according to the invention; and

Figures 3 and 4 are simplified schematic diagrams illustrating the operation of a communication system according to the invention.

DESCRIPTION OF AN EMBODIMENT

In the present invention, a cellular network is provided which comprises a plurality of fixed stations or base stations which define non-overlapping cells, so that there are no zones of interference between the various fixed stations. This allows for utilisation of the available transmission time slots without regard to the transmission of other base stations.

The obvious result of this arrangement is that there are "holes" or "dead" zones between the base stations where there is no effective coverage. In a conventional cellular communication system, mobile stations or handsets would be unusable in these dead zones. However, by utilising mobile stations which are able to relay messages from other mobile stations into the relevant cells, complete coverage can be obtained, provided that there are sufficient mobile stations present.

Suitable mobile stations are described in PCT Patent Application No. PCT/GB 95/02972, the contents of which are incorporated herein by reference.

The mobile transceivers described in the above mentioned specification operate by transmitting data messages opportunistically between themselves and other stations in order to relay messages from an originating station to a destination station. Such transceivers can be used to advantage in a cellular communication system organised as described above, where they effectively fill in the gaps in the coverage between adjacent cells, while

allowing the organisation of the cellular network itself to be simplified.

Figure 1 shows the overlapping of cellular coverage in a conventional cellular network, where each of the seven illustrated cells has an inner interference-free zone and an outer zone which overlaps with one or more adjacent cells and which is subject to interference.

Figure 2 shows the arrangement of the present invention, where the coverage of adjacent cells is non-overlapping, leaving "dead" zones between the cells.

In Figure 3, sixteen cells (numbered 1 to 16) are shown which are non-overlapping. These cells corresponds to the area of coverage of respective fixed or base stations. The smaller circles numbered 17 to 29 represent the areas of coverage of typical transmissions by respective mobile stations located in the "dead" zones between the cells 1 to 16. The small circles numbered 30 to 39 indicate the areas of coverage of typical transmissions by respective mobile stations within certain of the cells 1 to 16 which are communicating directly to the respective cell controllers or gateways simultaneously (that is, to the respective base stations). This latter condition is indicated by the overlapping of the circles 30 to 39 with the centres of the relevant cells 1 to 16.

The lack of overlap between the circles 17 to 29 indicates that there is no interference between the areas of coverage represented thereby. Also, since the circles 17 to 29 do not overlap the centres of any of the cells 1 to 16, the mobile relay stations are not interfering with the cell controllers. Simultaneously, each cell controller or base station needs to be able to use its own time slot, and this is represented by the circles 30 to 39 indicating data being transmitted during that time slot to each of the cell controllers. Since the circles 30 to 39 each only overlap the centre of the respective cells 1 to 16 which they are in, the mobile stations represented thereby do not interfere with the cell controllers of adjacent cells. Also, since the circles

30 to 39 do not overlap the circles 17 to 29, there is no interference with the mobile stations acting as relays. Therefore each cell controller has used its time slot. On the next transmission data could be sent from each of the relay stations (17 to 29) to the cell controllers and no loss of time slots would have occurred. This means that 100% usage of all time slots in all cells is possible, while ensuring 100% geographic coverage, with only relatively simple rules having to be implemented to achieve this.

In the case of transmissions into the base station cells, the rule is that a mobile station outside the region of coverage of the cell must transmit data to a relay station in such a fashion as not to interfere with the cell controller or gateway and to ensure that its transmission is below the noise floor of the gateway, whilst at the same time having a sufficient signal to noise ratio to reach a mobile station within the coverage area of the base station. A further rule is that the mobile station which is using a particular time slot to send data to the gateway should not interfere with the mobile station receiving the data and acting as a relay on behalf of the mobile station outside the coverage area of the base station.

Since there is no overlap between the various small circles there is no interference between these stations. There are therefore two types of transmission going on simultaneously:

1. Mobile stations (17 - 29) outside of cell coverage relaying to mobile stations within cells.

2. Mobile stations (30 - 39) inside of cell coverage communicating directly to cell gateways.

The above assumes that the mobile stations (30-39) have data to send for themselves, or data that they have received on a previous time slot from stations outside of the cell coverage.

The effect of lack of interference between the various transmissions is shown by the small circles in Figure 3, and it is evident that for any mobile station acting as a relay it should always be possible to find a mobile station within a cell to use the time slot and send data to the cell controller in such a way so as not to interfere with the relayer and for the relayer not to interfere with the cell controller.

The effect of two simultaneous transmissions occurring in a single cell on the same frequency, on the same time slot, is shown by two non-overlapping circles in each of the cells. Needless to say, in the case of each transmission hop, two smaller hops could be made to ensure that less area is covered (or more excluded) during those transmissions, but the basic principle is sufficiently shown.

It is conclusive that opportune hopping allows 100% use of all time slot resources at each controller, and if multiple frequencies or codes were available, these also could be used 100%. Through simplistic opportune hopping techniques, 100% of the available resource at each cell controller can be utilised without the significant timing and frequency synchronisation that is typical of a conventional cellular structure.

Such an effect is impossible in a cell structure that does not use subscriber relay. If a real geographic coverage plan is used the problem is significantly worsened, and if shadowing and fading and noise effects are taken into account, the use of conventional cellular techniques limits frequency re-use or time slot re-use in adjacent cells, requiring a frequency planning scheme.

The basic procedure required to implement a practical system according to the present invention is simple and can be summarised as follows:

For inbound transmissions (i.e. messages flowing from mobile stations outside the cell coverage area to the gateway or cell controller of a fixed

station):

1. A mobile station outside a cell in the "dead" region between adjacent cells needs to transmit its data to a mobile station inside one of the cells.

2. It does this by opportunistically choosing one of the three adjacent cells (or more in more complex arenas), and then sending data to that cell by sending it to one of the mobile stations in the cell.

3. This is done opportunistically, based upon sending the data to an opportunistically chosen mobile station that is not being interfered with by a transmission from another mobile station sending data to the cell controller within the cell.

4. The transmission is made by the mobile station outside the coverage area to a mobile station within the coverage area in such a way as not to interfere with the cell controller. This is shown figuratively in Figure 3, where transmissions occur at the same frequency within the same cell without interfering with each other, with at least two transmissions occurring simultaneously per cell on the same time slot, on the same frequency allocation or code allocation.

5. In the next time slot available the mobile station within the cell coverage area will send the data it has received to the cell controller.

6. Simultaneously, in the next time slot available, other stations outside of the coverage area can send their data to mobile stations inside the coverage area.

7. The above procedure can follow an opportunistic bucket brigade cycle with data continuously being provided in every time slot to the gateway with no interference, thereby ensuring 100% use of the gateway or cell controller.

For outbound transmissions (i.e. messages flowing from the cell controller to mobile stations outside of the cell coverage area):

1. The fixed network needs to send data to a mobile station outside the cell coverage area.

2. The network opportunistically chooses one of the three adjacent cells that are nearby to the subscriber (or more in more complex arenas).

3. This is done opportunistically, based upon sending the data to a cell controller that is not busy.

4. The cell controller then transmits the data to an opportunistically chosen mobile station (30-39) within its coverage area that is able to transmit the data on a subsequent time slot to the mobile station outside the coverage area. Simultaneously, mobile stations (30-39) that have received data on previous transmissions are sending data to mobile stations (17-29) outside the cell coverage area.

5. This is shown figuratively in Figure 4, where transmissions occur at the same frequency within the same cell without interfering with each other, with at least two transmissions occurring simultaneously per cell on the same time slot, on the same frequency allocation or code allocation.

6. In the next time slot available the mobile station within the cell

coverage area will send the data it has received to the mobile station outside the cell coverage area.

7. Simultaneously, in the next time slot, the cell controller can send data to another mobile station acting as a relay or directly to a mobile station within the cell coverage area.

8. The above procedure can follow an opportunistic bucket brigade cycle with data continuously being provided in every time slot from the gateway with no interference to the gateway by the mobile stations in the cell acting as relays, thereby ensuring 100% use of the gateway or cell controller.

The basic method has two simultaneous transmissions in each cell in each time slot:

1. The cell controller sends data directly to mobile stations within the cell coverage area (Figure 4) or to opportunistically selected relays within the cell coverage area which can then forward the data to stations outside the coverage area.

2. Simultaneously relays transmit data to mobile stations outside the cell coverage area so as not to interfere with the intended recipient of the simultaneous transmission by the cell controller within the same cell or any adjacent cell.

A simple simulation technique can extend this from a single time slot/frequency slot resource management to multiple time slots, or multiple code slots or multiple frequencies with the same effect holding true with the same rules being utilised.

Needless to say in a mobile telephone network the traffic flow is two way

and the outbound and inbound rules will be combined and work in tandem to best make use of the resource available at the cell controllers.

Dated this 3rd day of March 1997.

C. de Villiers

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FIG 3

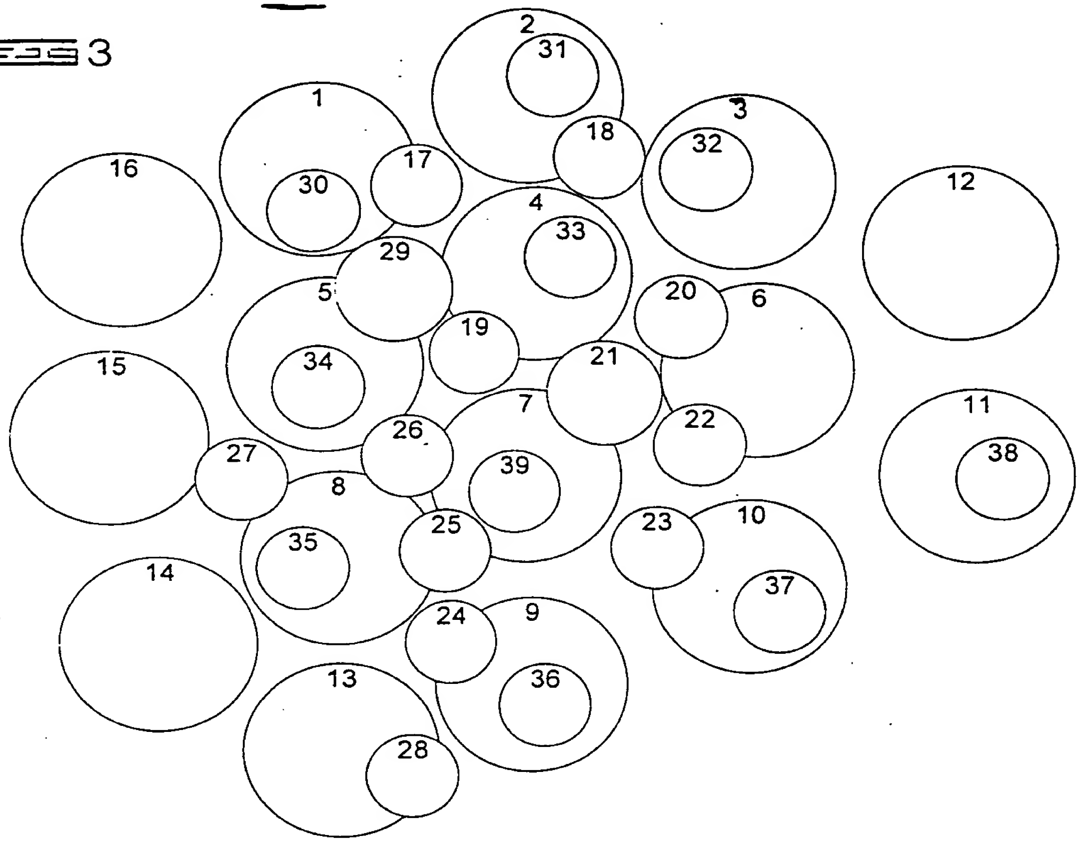
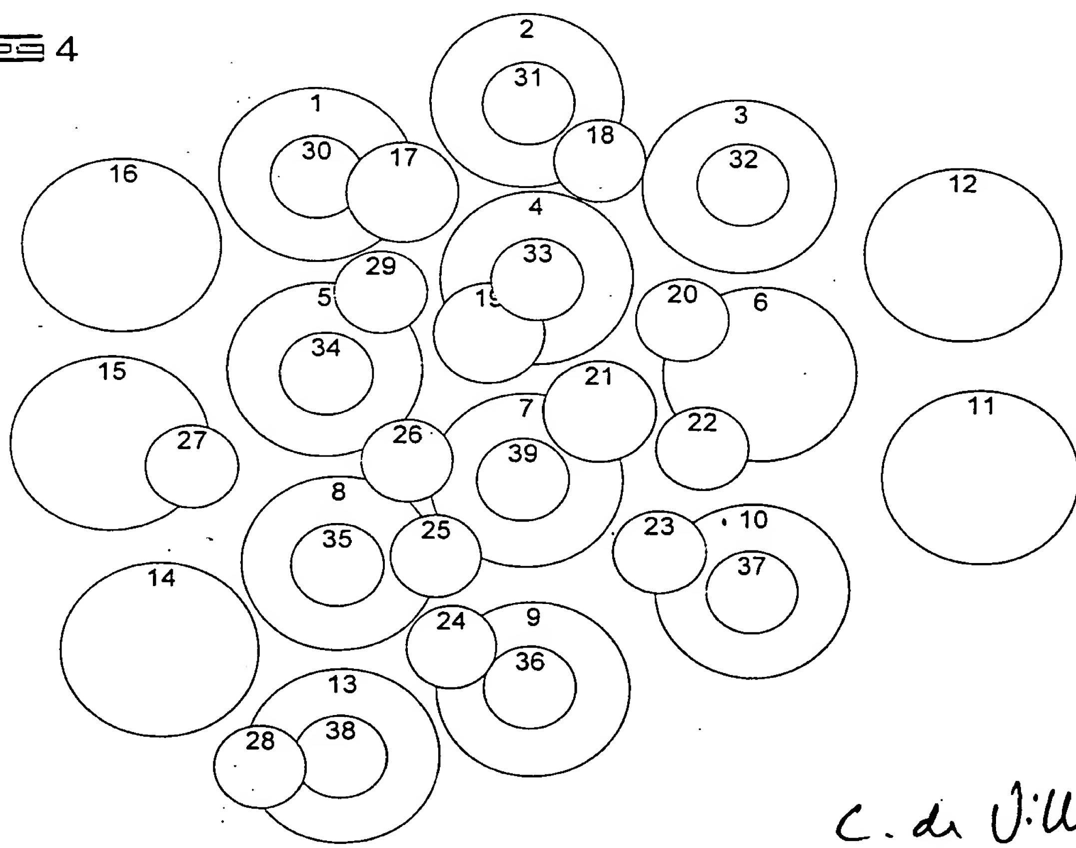


FIG 4



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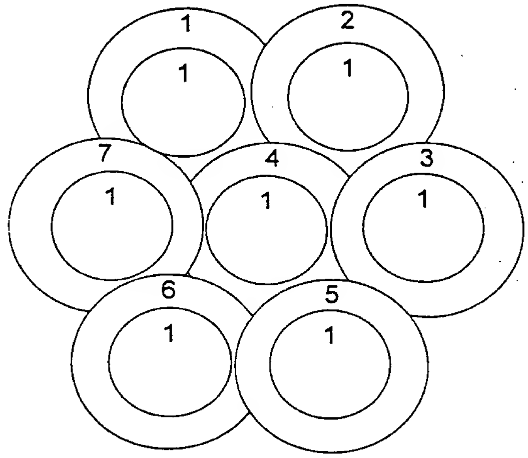

FIG 1

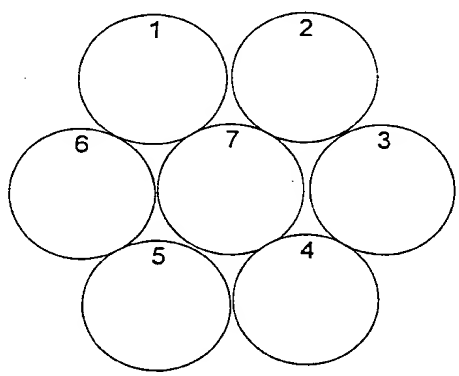

FIG 2

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